

Renewable Energy in India: Benchmarking and Opportunities

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Abstract: Demand of renewable energy increased greatly just after the first big oil crisis in the late seventies. At that time, economic issues were the most important factors, hence interest in such process decreased when oil price fell. The current resurgence of interest in the use of renewable energy is driven by the need to reduce the high environmental impact of fossil-based energy systems. To combat the climate change caused by fossil fuels the Kyoto protocol and Copenhagen accords were signed. These accords require signatories to greatly reduce emissions which require alternative energy sources such as renewable energy. Solar energy is one of the potential sources of renewable energy that can reduce dependency on fossil fuels. Due to simplicity, availability, reliability and low maintenance photovoltaic (PV) arrays are an ideal option for many countries. In Indian subcontinent receiving lot of sunlight and with a well designed application solar can provide large amounts of power at low cost. The aforementioned reasons, makes solar power a great option for addressing power crisis in India. This paper starts with the introduction of renewable energy and the need felt to switch to renewable energy resource. In addition, renewable energy allows for increased energy access to the Indian people, especially in the rural and remote areas, catering to their basic energy needs. This paper also attempts to analyze the different promotional strategies adopted within a regulatory framework in India.

Keywords: Renewable Potential, Policy support, REC Framework, Recent Initiative.

I. INTRODUCTION

With the increasing demand of energy and growing depletion of resources for energy generation a global movement towards production of renewable energy (RE) is being thought. Renewable Energy is generated from resources which are renewable or which may last forever like sunlight, wind, rain, tide, geothermal heat etc. Small hydro generation also falls under the Renewable Energy. Opposite to RE, energy generated from conventional sources like fossil fuels or gas are formed by natural resources such as anaerobic decomposition of buried dead organisms. Fossil fuels- the non-renewable resources take millions of years to form, and reserves are getting depleted much faster than the new ones being formed. The production and use of fossil fuels raises environmental concerns. A global movement towards the generation of renewable energy is therefore under way to help Meet increased energy needs. Renewable energy is becoming an increasingly important element of India's national energy mix. The huge potentials of the country in renewable energy are recognized as an additional important energy source which can contribute to the key policy objectives of the energy sector, given the ever increasing prices and the shortages in fossil fuel supplies. By diversifying the energy mix in a climate friendly way and by increasing the energy security at the same time, the main benefits of renewable energy for India become obvious. In addition, renewable energy allows for increased energy access to the Indian people, especially in the rural and remote areas, catering to their basic energy needs.

A. Policy Support For Renewable Energy:

India has been ranked by the IMF as the world's tenth largest economy and the third largest by purchasing power parity. The Indian economy has been growing at an annual average rate of around 8 percent, coupled with an increasing urbanization and an ever increasing demand for energy. The Integrated Energy Policy of India, which is geared towards an annual GDP growth rate of 9 percent through 2031-32, estimates the increase in primary energy supplies to 4 to 5 times and the increase in electricity generation to 6 to 7 times from the 2003-04 levels. The total potential for renewable in

India, as per the Ministry of New and Renewable Energy (MNRE), is around 245 GW, while the current installed capacity is 29 GW. Only around 12% of the country's potential has been exploited so far. In the wake of power deficits and increasing costs of conventional sources of power, India's energy security is at a major issue for the government, especially to sustain long term economic growth of the country. Renewable energy has been categorized as traditional and new renewable energy. The former includes large hydropower, biomass burnt directly etc. the latter includes small hydropower, solar energy, wind energy, biomass energy, geothermal energy and ocean energy, etc. This paper deals with the new renewable energy sources. Grid connected installed capacity from all sources as of 28 February 2017 is tabled below

Table 1: Grid Connected Installed Capacity

Source	Installed Capacity (MW)	Share
Coal	189,047.88	59.93%
RES MNRE	50,018.00	15.86%
LARGE HYDRO	44,413.43	14.08%
Gas	25,329.38	8.03%
Diesel	837.63	0.27%
Nuclear	5,780.00	1.83%
Total	315,426.32	100.00%

Source: Ministry of New and Renewable Energy (MNRE)

Installed grid interactive renewable power capacity (excluding large hydropower) as of 31 March 2018 (RES MNRE) is tabled below

Table 2: Installed grid Interactive Renewable Power

Source	Total Installed Capacity (MW)	2022 target (MW)
Wind power	34,046	60,000.00
Solar power	21,651	100,000.00
Biomass power (Biomass & Gasification and Biogases Cogeneration)	8,701	10,000.00
Waste-to-Power	138	
Small hydropower	4,486	5,000.00
TOTAL	69,022	175,000.00

Source: Ministry of New and Renewable Energy (MNRE)

Government of India has come out with Acts, Policies and regulations to support Renewable Energy. The major contributors are as under

B. Electricity Act 2003:

Section 86 (1): The State Commission shall discharge the following functions (e): promote cogeneration and generation of electricity from renewable sources of energy by providing suitable measures for connectivity with the grid and sale of electricity to any person, and also specify, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution licensee.

C. National Electricity Policy 2005:

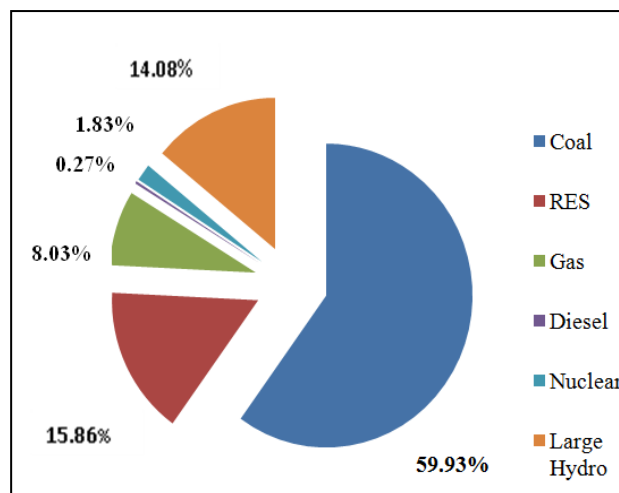
The National Electricity Policy 2005 stipulates that progressively the share of electricity from non-conventional sources would need to be increased; such purchase by distribution companies shall be through competitive bidding process; considering the fact that it will take some time before non-conventional technologies compete, in terms of cost, with conventional sources, the commission may determine an appropriate differential in prices to promote these technologies.

D. Tariff Policy 2006:

The Tariff Policy announced in January 2006 has the following provisions:

- (i) Pursuant to provisions of section 86 (1) e of the Act, the Appropriate Commission shall fix a minimum percentage for purchase of energy from such sources taking into account availability of such resources in the region and its impact on retail tariffs. Such percentages for purchase of energy should be made applicable for the tariffs to be determined by the SERCs latest by April 01, 2006.
- (ii) It will take some time before non-conventional technologies can compete with conventional sources in terms of cost of electricity. Therefore, procurement by distribution companies shall be done at preferential tariffs determined by the Appropriate Commission.
- (iii) Such procurement by Distribution Licensees for future requirements shall be done, as far as possible, through competitive bidding process under Section 63 of the Act within suppliers offering energy from same type of non-conventional sources. In the long-term, these technologies would need to compete with other sources in terms of full costs.
- (iv) The Central Commission should lay down guidelines within three months for pricing non-firm power, especially from non-conventional sources, to be followed in cases where such procurement is not through competitive bidding.

E. Central Electricity Regulatory Commission (CERC):



Source: CEA – Feb, 2018

Fig 1: Technology –wise distribution of installed capacity in India

Contribution of renewable energy sources in the total portfolio of capacity as well as gross generation is still very low. As on 28 February 2017, the renewable energy sources constituted only about 15 % of the total installed generation capacity (315,426.32MW) in the country. The National Action Plan of Climate Change (NAPCC) has set the target of 5% renewable energy purchase for FY 2009-10 which will increase by 1% for next 10 years. The NAPCC further recommends strong regulatory measures to fulfill these targets. This would mean NAPCC envisages renewable energy to constitute approx 15% of the energy mix of India. This would require quantum jump in deployment of renewable energy across the country. To achieve these targets, NAPCC etc mandates an instrument called Renewable Energy Certificate (REC).

II. RENEWABLE ENERGY CERTIFICATE

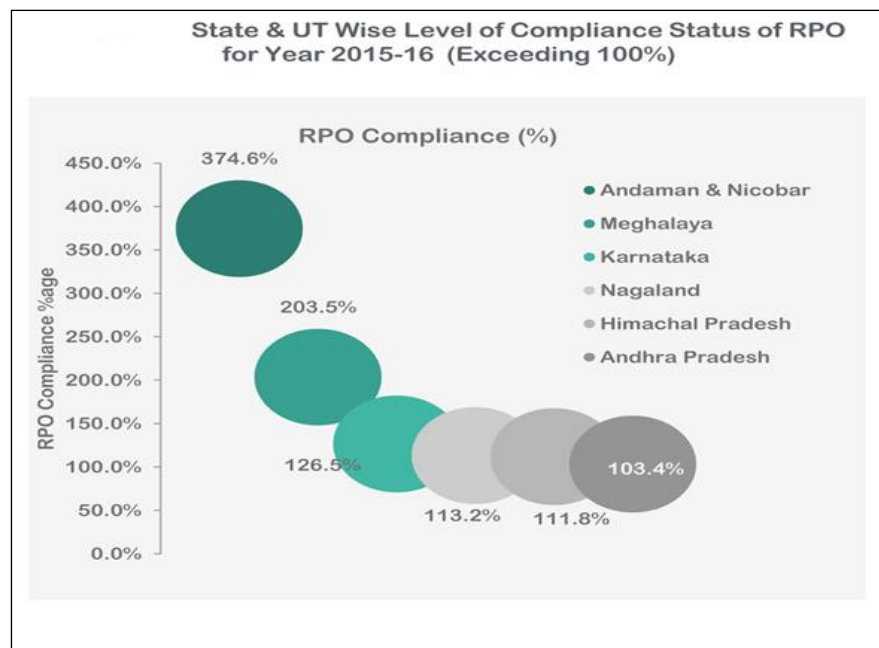
The government of India, through its commitments in the National Action Plan for Climate Change (NAPCC), has introduced Renewable Purchase Obligations (RPO). The RPO mechanism is a demand side measure which requires some designated “obligated entities” to include a specified share of renewable power in their overall power mix. Power Distribution Companies (DISCOMs), both private and public as well as the open access consumers and the captive

consumers, are obligated entities. Obligated entities can meet their RPOs by two methods: They can set up their own renewable energy (RE) power plant or, in the case of DISCOMs, they can buy the power directly from a RE plant by signing a Power Purchase Agreement (PPA) with the developer of the plant. Alternatively they can buy Renewable Energy Certificates (REC) from RE generators. A REC is issued to a developer who generates 1MWh of renewable power from a plant that has been registered with the central or state power load dispatch centre. An REC can then be purchased by an obligated entity on the Indian Energy Exchange (IEX) or the Power Exchange India Limited (PXIL) for a bid amount within the predefined floor (lower limit) and the forbearance (upper limit) price limit.

A REC is a paper or electronic instrument which represents the property rights to the environmental, social, and other non-power qualities of renewable energy generation. REC and its associated attributes and benefits, can be sold separately from the underlying physical electricity associated with a renewable-based generation source.

A. REC in Indian Context:

In India some states like Rajasthan and Tamil Nadu have very high potential of RE sources and the State Commissions have also specified higher RPO. In fact, in such states there are avenues for harnessing the potential even beyond the RPO level fixed by the State Commissions. However, the very high cost of generation from RE sources discourages local distribution licensees from purchasing electricity generated from RE sources beyond the RPO level mandated by the State Commission.



Source: MNRE – Feb, 2016

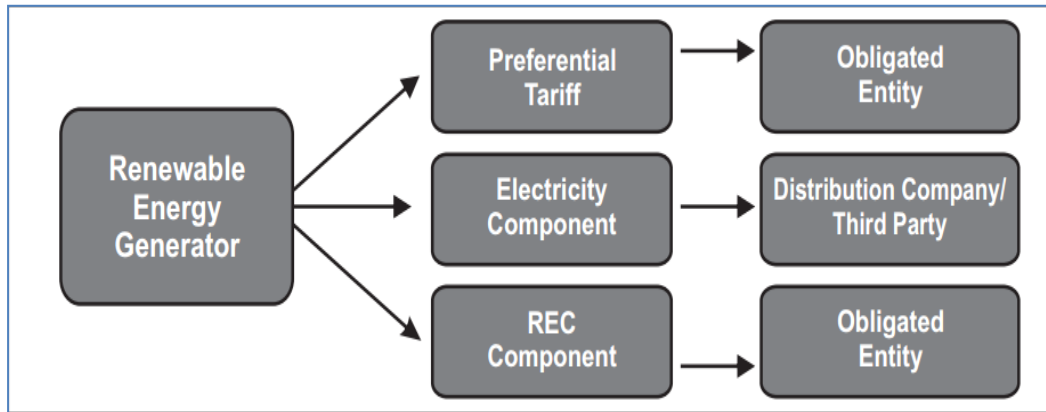
Fig 2: State wise level of compliance status of RPO in India

It is in this context that the concept of Renewable Energy Certificate (REC) assumes significance. This concept seeks to address the mismatch between availability of RE sources and the requirement of the obligated entities to meet their renewable purchase obligation.

In view of the above contexts and to overcome the regional constraints, after detailed deliberations with all stakeholders, CERC notified the —Central Electricity Regulatory Commission (Terms and Conditions for recognition and issuance of Renewable Energy Certificate for Renewable Energy Generation) Regulations, 2010 on 14th Jan-2010, introducing the modalities of REC in the Indian Electricity Sector. RECs are also known by under functionally equivalent names such as Green Tags, Renewable Obligation Certificates or Tradable Renewable Certificates. Internationally in countries like UK, US, Australia, Japan, Netherlands, Denmark & Poland the concept has been used to facilitate a robust and credible market for trading the green attributes of the electricity, with a view to provide an additional source of revenue to renewable energy generators.

III. REC FRAME WORK

Renewable Energy Certificate (REC) mechanism is a market based instrument to promote Renewable Energy to Facilitate Renewable Purchase Obligation (RPO). REC mechanism is aimed a mismatch between availability of RE resources in state and the requirement of the obligated entities to meet the renewable purchase obligation (RPO). Cost of electricity generate sources is classified as cost of electricity generation Equivalent to conventional energy sources and the cost for environmental attributes.



Source: S.K.Soonee, Satya Prakash (2010): 'Renewable Energy Certificate Mechanism in India'

Fig 3: Renewable Energy Certificate Mechanism

REC will be issued to the RE generators for 1 MWh of electricity injected into the grid from renewable energy sources. The Certificate once issued shall remain valid for three hundred and sixty five days from the date of issuance of such certificate. REC would be issued to RE generators only. REC could be purchased by the obligated entities to meet their RPO under section 86 (1) (e) of the Act. Purchase of REC would be deemed as purchase of RE for RPO compliance. Grid connected RE Technologies approved by MNRE would be eligible under this scheme. RE generations with existing Power Purchase Agreement on preferential tariff are not eligible for REC mechanism. SERC to recognize REC as valid instrument for RPO compliance. SERC would define open access consumers, captive consumers as obligated entities along with distribution companies. SERC to designate State agency for accreditation for RPO compliance and REC mechanism at State level. CERC has designated National Load dispatch Centre (NLDC) as Central Agency for registration, repository, and other functions for implementation of REC framework at national level. Only accredited project can register for REC at Central Agency.

The Central Agency would issue REC to RE generators for specified quantity of electricity injected into the grid. REC would be exchanged only in the CERC approved power exchanges. Central will extinguish Agency the RECs sold in Power Exchanges in its records as per information provided by the Power Exchanges. The certificates will be extinguished by the Central Agency in the 'First-in First-out' order. Price of electricity component of RE generation would be equivalent to the weighted average power purchase cost of the discom including short term power purchase but excluding renewable power purchase. REC would be exchanged within the forbearance price and floor price. This forbearance and floor price would be determined by CERC in consultation with Central agency and FOR (Forum of Regulators) from time to time. In case of default, SERC may direct obligated entity to deposit into a separate fund to purchase the shortfall of REC at forbearance price. However, in case of genuine difficulty in complying with the renewable purchase obligation because of non-availability of certificates, the obligated entity can approach the Commission for carrying forward of compliance requirement to the next year.

IV. RECENT INITIATIVES AND FUTURE ASPECTS

CREC has notified National Load Dispatch Centre as the Central Agency for implementation of REC Mechanism in India. CERC has determined floor price and forbearance price for dealing in certificates under the REC Regulations with effect from 1st April 2017. The following forbearance and floor price and forbearance price shall be valid until further orders by the CREC.

Table 3: Present Offer of Floor Price and Forbearance Price

	Non Solar REC (Rs/ MWh)	Solar REC (Rs/ MWh)
Forbearance Price	2,900	2,500
Floor Price	1,000	1,000

Source: CERC NEW DELHI

The Government has up-scaled the target of renewable energy capacity to 175 GW by the year 2022 which includes 100 GW from solar, 60 GW from wind 10 GW from bio-power and 5 GW from small hydro-power. The target of 100 GW capacity set under the National Solar Mission (NSM) will principally comprise of 40 GW Rooftop and 60 GW through Large and Medium Scale Grid Connected Solar Power Projects. With this target, India will become one of the largest Green Energy producers in the world, surpassing several developed countries. Government of India in its submission to the United Nations Framework Convention on Climate Change on Intended Nationally Determined Contribution (INDC) has stated that India will achieve 40% cumulative Electric power capacity from non-fossil fuel based energy resources by 2030. In continuation of the new initiatives launched in the previous year, the Government has taken up the following new projects/schemes during the current financial year:

A. Green Energy Corridor:

An Rs.38, 000 crore Green Energy Corridor is being set up to ensure evacuation of Renewable Energy. Power Grid Corporation of India Limited (PGCIL) has sought Loan assistance of US\$ 1,000 million from the Asian Development Bank (ADB) comprising of Sovereign guaranteed loan of US\$ 500 million and Non-Sovereign loan of US\$ 500 million. The loan would be utilized for funding of the following transmission projects including a project under Green Energy Corridor projects in next 3-4 years.

B. Renewable Purchase Obligation:

Pursuant to the revised tariff policy, the Ministry of Power on 22nd July 2016 has notified the long term growth trajectory of RPO for solar and non-solar energy for next 3 years 2016-17, 2017-18 and 2018-19 as given

Table 4: Growth trajectory of RPOs

Long term trajectory	2016-17	2017-18	2018-19
Non-solar	8.75%	9.50%	10.25%
Solar	2.75%	4.75%	6.75%
Total	11.50%	14.25%	17.00%

Source: Annual Report of 2016-17, MNRE

C. Net Metering Policy:

The consistent follow-up by the Ministry resulted into the notification by State Electricity Regulatory Commissions (SERCs) of thirty four States on net-metering and feed-in-tariff to encourage rooftop solar plants. Net-metering scheme has been rolled out in all States/ UTs which will help in meeting 40 GW rooftop grid connected solar projects. So far, 20 States namely Andhra Pradesh, Chhattisgarh, Delhi, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Manipur, Punjab, Pondicherry, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand and West Bengal have come out with Solar Policy supporting grid connected rooftop systems.

D. Wind Power:

Comprehensive Guidelines for Development of On-shore Wind Power Projects in the country have been formulated and issued. Guidelines for implementation of "Scheme for Setting Up of 1000 MW Inter-State Transmission System (ISTS) - connected Wind Power Projects" issued. The Policy for Repowering of the Wind Power Projects has been released on 5th August, 2016 to promote optimum utilization of wind energy resources by creating facilitative framework for repowering.

E. Solar Rooftops:

All major sectors i.e. Railways, Airports, Hospitals, Educational Institutions; Government Buildings of Central/State/PSUs are being targeted besides, the private sector. Ministry has tied up with ISRO for Geo tagging of all the Rooftop plants using ISRO's VEDAS portal. Ministry of Finance approved raising Rs. 4000 crore bonds for renewable energy sector by IREDA during 2016-17.

F. Solar Tariff Attaining Grid Parity:

Solar tariffs have fallen to an unprecedented low of Rs.4.34 / kWh through reverse auction for one of six projects of 70 MW each to be put up in Rajasthan under the National Solar Mission. This trend is continuing and is moving towards grid parity.

G. Skill Development:

Surya Mitra Scheme has been launched for creating 50,000 trained solar photovoltaic technicians by March 2020. A total number of 7500 Surya Mitra's would be trained by 31.03.2017. A network of over 200 Institutions, spread all over the country, have been created for implementing Surya Mitra scheme. In addition, short term training programs for small hydro, entrepreneurship development, operation & maintenance of solar energy device and boiler operation in co-generation plants have been organized.

H. International Solar alliance:

International Solar Alliance was launched as a special platform for mutual cooperation among 121 solar resource rich countries lying fully or partially between Tropic of Cancer and Tropic of Capricorn at COP21 in Paris on 30th November, 2015 to develop and promote and Tropic of Capricorn at COP21 in Paris on 30th November, 2015 to develop and promote for the proposed Headquarters of the ISA was laid at Gurgaon, Haryana (India). The International Steering Committee (ISC) of the ISA has held four meetings so far. The Framework Agreement of ISA has been finalized after discussions with various stakeholders.

V. CONCLUSION

To make the country self sufficient in electricity, large number of Renewable energy projects are to be installed. This would also reduce CO₂ in the air and also this will further reduce the air pollution. Hence national level awareness regarding efficient renewable energy options, efforts is required for promoting research and development in these alternative technologies and resources. Developments in renewable technologies are, however, progressing rapidly both in India and across the world, and higher levels of regional cooperation can play a key role in accelerating the pace and spread of renewable energy development. By 2050, some estimates put India's power generation requirements at one terawatt, or one trillion watts. This would be a six fold increase in India's current installed power capacity. It is a big challenge. But it is a big opportunity too, for Indian companies, for the creation of Indian jobs, for greater Indian prosperity.

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